Aeromedical Research Resume
Research Project Description Task for FY2001

1. Title: ATS Workforce Analysis and Selection Requirements	*2. Sponsoring Organization/Focal Point (FP)* ARX-1; J. Staples AAM-1; J. Jordan, M.D. ARX-20; S. Pansky (FP) AAR-100; L. Cole	*3. Originator Name, Organization, Phone :* Dana Broach, Ph.D. Michael Heil, Ph.D. AAM-520 (405) 954-6840
		4. Origination Date: October 1, 1998
5. Parent RPD Number: 586	*6. Task Number:* AM-B-01-HRR-517	*7. Completion Date:* September 30, 2001
8. Parent MNS: ATS Human Factors	*9. RPD Manager Name, Organization, Phone:* David J. Schroeder, Ph.D. (AAM-500) FAA Civil Aeromedical Institute (405) 954-4846	

10. Research Objective(s):

To develop and validate personnel selection criteria and tools to support near-term (FY1999 - FY2001) hiring requirements for the air traffic control specialist (ATCS; FG-2152), environmental and electronics technicians (ET; FG-0802 and 0856), and airway transportation systems specialist (ATSS; FG-2101) occupations.

To continue development of a prototype methodology and tool for identification, description, and analysis of gaps between current and future ATS workforce knowledge, skill, and ability (KSA) and staffing profiles required under the ATS *Concept of Operations*, proposed *NAS Architecture v4.0*, and Free Flight Phase I.

11. Technical Summary:

The current controller, technician, and systems specialist ATS workforce was selected on the basis of the KSAs required to operate, maintain, and manage today's NAS architecture. However, the emerging modernized NAS envisioned under the *ATS Concept of Operations for the National Airspace System in 2005*, Free Flight (Phase I), and the proposed *NAS Architecture v4.0* may require new KSAs of controllers, technicians, and systems specialists. This research focuses on identifying gaps between current and future ATS workforce KSA and staffing profiles and the development of validated selection processes to reflect those KSA requirements for the ATS technical workforce. The tools and methodologies of workforce planning, job analysis, job performance measurement, test validation, and utility analysis will be applied in this task to (a) develop a methodology and tool for the identification, description, and analysis of gaps between current and future ATS workforce KSA and staffing profiles, and (b) develop, validate, and evaluate selection criteria based on continuing and new KSA requirements associated with the modernized NAS for the ATCS (FG-2152), ET (FG-0802/0856), and ATSS (FG-2101) occupations.

12. Resources Requirements:	FY 99	FY 00	FY 01
FAA Staff Years	5.0	5.0	5.0

13. Description of Work:

(1) Brief Background

   FAA must replace controllers, technicians, and systems specialists who attrite from the workforce through retirement in the near-term (FY2000 - FY2002). GAO projected 270 ATCS retirements in FY2001. FAA agreed to a staffing level of 15,000 controllers in the terminal and en route facilities in the FAA-NATCA 1998 contract. With projected retirements of about 200-300 controllers in FY2001 and beyond, an equal number of new controllers each year will be needed to maintain the negotiated target workforce staffing levels, apart from any growth required to accommodate increased traffic operations. In contrast, hiring requirements in Airway Facilities have dramatically declined as that workforce begins to downsize through attrition. For example, there were just 36 new hires in the FG-2101 occupation in FY2000, with less than 100 projected for FY2001. However, there continues to be substantially more applicants than positions to be filled in both the FG-2152 and FG-2101 occupations. Therefore, the FAA will continue to require validated criteria to select the few that possess the appropriate knowledge, skill, and ability (KSA) profiles from among the many applicants. This research specifically addresses this requirement for validated near-term hiring tools.

Previous selection research by CAMI in cooperation with ATS resulted in the development and initial validation of the (a) Airway Facilities Centralized Applicant Pools System (AFCAPS), a computer-based applicant screening tool, and (b) two modular, computer-administered tests of KSAs (e.g., the Airway Facilities Basic Electronics Screening Tool (AF/BEST) and Air Traffic Selection and Training (AT-SAT) battery). Research under this ARR resulted in a successful "proof of concept" for use of computer technology to generate certain classes of KSA test items under the Variable Item Generator (VIGOR) procurement in FY2000. CAMI research under this ARR investigated the effects of age, coaching, and practice on AT-SAT scores and validity. Finally, CAMI hosted the 1st International Conference on Air Traffic Controller Selection in FY1999 to establish the groundwork for sharing selection-oriented research with Eurocontrol and other ATC authorities.

Additional near-term (FY2001) research is required to (a) develop an ATCS applicant screening tool, (b) conduct additional validation studies of the AF selection tools in accordance with the Civil Rights Act (42 **USC** 2000) and Uniform Guidelines on Employee Selection Procedures (29 **CFR** 1607), and (c) begin development of parallel forms of AT-SAT to provide test security and protect its utility and validity. Longer-term research is needed to develop (a) controller job performance measures for the TRACON and tower CAB and (b) job performance measures for the AF field maintenance workforce assigned to work centers, system support center, systems operations centers, and maintenance control centers.

The FAA will continue to modernize the NAS under the ATS Concept of Operations for the National Airspace System in 2005 and the NAS Architecture v4.0. The Administrator's 1998 NAS Modernization Task Force identified a need to identify, describe, analyze, and resolve gaps between current and future workforce KSA and staffing profiles in that modernization effort. The NAS Sustainability Core Team recommended that workforce analysis be integrated into the FAA Acquistion Management System (AMS). However, such workforce analysis tools, to address staffing, hiring, training, and KSA profiles, are not currently available in the FAA. To address this requirement, near-term (FY2001) research is needed to (a) complete development of a mathematical, probability-based model for forecasting controller retirements and attriton (Statistical Controller Retirements-Attrition Model (SCRAM)) for use by Air Traffic, and (b) begin development of a comprehensive baseline analysis of the KSA requirements for the AF field maintenance workforce to support future selection procedure development and validation for AF.

(2) Statement of Work

Task 1: Develop and validate computerized application evaluation systems with standardized rating and ranking algorithms for ATCS, ET, and ATSS occupations within ATS. These application systems are the first phase of selection. They provide a tool for evaluating large numbers of applicants quickly and efficiently against occupational qualification standards. For example, the AFCAPS application form and computerized scoring, rating, and ranking algorithm were developed by the CAMI Selection and Validation Team in 1996 and 1997. AFCAPS also provides the capability to make tentative grade determinations on the basis of education, training, and experience. Only candidates who qualify for the grade being hired are then referred to the next phase of more intensive, and expensive, formal testing of electronics skills and knowledge. An evaluation of the fairness, reliability, validity, and effectiveness of AFCAPS is required under 42 USC 2000 and 29 CFR 1607. This research will specifically address that mandated, legal requirement by completing in FY2001 a formal validation of AFCAPS relative to available criteria provided by AF.

AT intends to implement a similar approach called ATCAPS for evaluation of candidates relative to basic occupational qualification standards. However, under ATCAPS, applicants meeting basic qualifications will be referred on the basis of a lottery to the more intensive and expensive formal testing of required cognitive aptitudes. Such an approach does not take into account applicant training, education, experience, and other biographical characteristics that are predictive of success in training and on the job, and that might be inexpensively assessed at the time of application. A prototype biographical assessment of applicants will be developed in FY2001 for ATCAPS through cooperative research with the University of North Texas and University of Oklahoma.

Task 2: Develop technical refinements to and conduct longitudinal validations of prototype modular, computer-based selection tests for near-term hiring into the ATCS, ET, and ATSS occupations within ATS. Modular, computer-based tests such as AT-SAT (Air Traffic Selection and Training) and AF/BEST (Airway Facilities Basic Electronics Screening Tool) serve as the second, more intensive assessment of job-related knowledges, skills, and abilities. Longitudinal studies of the fairness, reliability, and validity of the prototype batteries are required under 42 USC 2000 and 29 CFR 1607. A formal validation of BEST relative to available criteria provided by AF will be completed in FY2001.

Task 3: Develop a prototype workforce analysis application, for identification, description, and analysis of gaps between current and future workforce KSA and staffing profiles in the NAS architecture. As documented by the NAS Sustainability Core Team report (1998) and the Administrator's NAS Modernization Task Force, workforce planning issues such as staffing, hiring, training, and KSA profiles have not been addressed in a systematic manner in the identification of mission needs, comparison of investment alternatives, and implementation of solutions to those mission capability shortfalls. Nor have the changes in workforce KSA and staffing profiles resulting from new techology implementations or proposals been systematically tracked for long-range impacts on staffing, hiring, and training. Development of such a workforce analysis tool, for integration in the AMS, requires development of detailed and specific current job and incumbent workforce KSA and staffing data bases. In addition,such workforce analysis requires a methodology for identifying and evaluating changes in KSA and staffing profiles resulting from new technologies or changes in mission requirements.
The CAMI Selection and Validation Research Team directed the initial development of a strategic job analysis methodology in 1997. This research proposes to build on that prototype methodology by (a) completing development of a mathematical, probability-based model for forecasting controller retirements and attritions, and (b) beginning development of a comprehensive baseline analysis of the KSA requirements for the AF field maintenance workforce to support future selection procedure development and validation for AF in FY2001.

14. Intended End Products/Deliverables:

Application forms and scoring algorithms for automated, standardized scoring, rating, and ranking of applicants to the ATCS, ET, and ATSS occupations on the basis of training, education, experience, and other biographical characteristics.

Broach, D. (1998). *Description of the AFCAPS scoring algorithm.* Oklahoma City, OK: Civil Aeromedical Institute Training & Organizational Research Laboratory.

Modular, computer-administered tests of job-relevant KSAs, with parallel forms, for the ATCS, ET, and ATSS occupations.

Airway Facilities:
FAA BEST v2.0c [Distribution software incorporating Variable Item Generator (VIGOR) technology], May 2000.
Dela Rosa, M., McBride, J., Smith, D., Waugh, G., & Tsacoumis, S. (1999). *Variable Item Generator: Item facet identification study.* Alexandria, VA: Human Resources Research Organization.
McBride, J., & Tsacoumis, S. (2000). *Variable Item Generator: Item facet evaluation study.* Alexandria, VA: Human Resources Research Organization.
Waugh, G., McBride, J., Dela Rosa, M., Smith, D., Quartetti, D., & Tsacoumis, S. (2000). *Variable Item Generator: Item facet manipulation study.* Alexandria, VA: Human Resources Research Organization.
Hom, I. (2000). *Variable Item Generator: BEST/Vigor integration report.* Alexandria, VA: Human Resources Research Organization.

Selection test reliability, fairness, and validity reports in accordance with 42 **USC** 2000 and 29 **CFR** 1607:

Air Traffic:
Heil, M.C. (1999). *An investigation of the relationship between chronological age and indicators of job performance for incumbent Air Traffic Control Specialists.* (DOT/FAA/AM-99/18). Washington, D.C. Federal Aviation Administration Office of Aviation Medicine.
Heil, M.C. (1999). *Air Traffic Control Specialist age and cognitive test performance.* (DOT/FAA/AM-99/23). Washington, D.C. Federal Aviation Administration Office of Aviation Medicine.
Heil, M.C., Agen, R., Williams, C., & Agnew, B.O. (2000). *The effects of practice and coaching on Air Traffic-Selection and Training (AT-SAT) test performance.* (DOT/FAA/OAM Technical Report). Manuscript in preparation.
Heil, M.C., & Agnew, B.O. (2000). *The impact of previous computer experience on Air Traffic-Selection and Training (AT-SAT) test performance.* (DOT/FAA/AM-00/12). Washington, D.C. Federal Aviation Administration Office of Aviation Medicine.
Manning, C.A., & Heil, M.C. (2000). *The relationship of FAA archival data to AT-SAT predictor and criterion measures.* (DOT/FAA/OAM Technical Report). Manuscript under review.
Ramos, R., Heil, M.C., & Manning, C.A. (Eds.) (2000). *Documentation of validity for the AT-SAT computerized test battery.* (DOT/FAA/OAM Technical Report). Manuscript under review.
Broach, D. (1999). *An examination of the relationship between air traffic controller age and en route operational errors.* Paper presented at the 10th International Symposium on Aviation Psychology, Columbus, OH.
Russell, C. J., Dean, M. A., & Broach, D. (2000). *Guidelines for bootstrapping validity coefficients in ATCS selection research.* (DOT/FAA/AM-00/15). Washington, DC: Federal Aviation Administration Office of Aviation Medicine.
Broach, D., Farmer, W. L., & Young, W. C. (1999). *Differential prediction of FAA Academy performance on the basis of race and written Air Traffic Control Specialist aptitude test scores.* (DOT/FAA/AM-99/16). Washington, DC: Federal Aviation Administration Office of Aviation Medicine.

14. Intended End Products/Deliverables (Continued):

Prototype, computer-based workforce analysis methodology and databases to support the identification, description, and analysis of gaps between current and future workforce KSA and staffing profiles.

Broach, D. (1999, June). *A preliminary analysis of air traffic control specialist job knowledge, skill, and ability requirements associated with selected Free Flight Phase 1 technologies.* Paper presented at the 1st International Conference on Air Traffic Controller Selection, Oklahoma City, OK.
Broach, D. (1999, May). *Retirement projects for the air traffic controller workforce.* Paper presented at the 10th International Symposium on Aviation Psychology, Columbus, OH.

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15. Schedule/Milestones:

	FY99
Prototype AF applicant database for longitudinal validation of AF/BEST	Completed Q3
Workforce analysis baseline KSA-by-job matrices for selected ATS occupations	Contract cancelled at request of AF in 4Q FY00 after 1 year delay by AF; re-award in Q1 FY01
	FY00
Variable Item Generator (VIGOR) technology integrated with AF/BEST for on-line generation of test items	Completed Q3
Workforce analysis future KSA-by-job matrices for selected NAS modernization projects and ATS occupations	Delayed to 2002 by baseline JTA cancellation & recompete request from AF
	FY01
Prototype AT/CAPS standardized rating and ranking system	Q4
AT-SAT parallel form	Contract awarded 3Q FY00; work start contingent upon AT direction
Terminal Computer-Based Performance Measures	Deferred to +3 years from implementation of AT-SAT
Inventory of current workforce KSAs relative to future requirements in selected ATS occupations	Delayed to 2002-2003 timeframe, pending completion of baseline JTA for AF
Technical evaluation reports on entry-level ATS selection procedures in accordance with 42 **USC** 2000 and 29 **CFR** 1607	Q4
Prototype workforce analysis tool for initial integration into AMS	Delayed to 2003-2004 timeframe, pending completion of baseline JTA for AF

16. Procurement Strategy/Acquisition Approach/Technology Transfer:

If fully funded, contractual vehicles such as the AHR Multiple Services (Operations/Analysis), GSA Mangement, Organizational and Business Services (MOBIS; http://pub.fss.gsa.gov/services/mobis-html), DOT Information Technology Omnibus Procurement (ITOP; http://itop.dot.gov), the GSA Information Technology Services (FEDSIM; http://www.gsa.gov/iti/swmgmt2.htm) contracts, or other procurement vehicle will be used to:

(a) Conduct selection-oriented, baseline job-task analysis for AF field maintenance workforce (award in Q1 FY2001 with completion in FY2002)
(b) Complete AT-SAT parallel form development, contingent upon AT decisions regarding re-programming and implementation of AT-SAT (FY2001-2002);
(c) Complete prototyping of ATCAPS biographical inventory and scoring key (FY2001); and
(d) Develop Statistical Controller Retirements-Attrition Model (SCRAM) application for desktop use by Air Traffic in MicroSoft Office®/Windows® environment (FY2001)

No major equipment acquisition ($5,000 or more) is anticipated for this project.

Technology transfer will be made available through the scientific media, direct briefings, and existing FAA structures. Transfer of FAA ATCS selection technologies to foreign countries will be accomplished through appropriate international agreements.

Data and products resulting from this research sub-task have application to other lines of research. For example, data describing the baseline and future job profiles can be used as a basis for identifying potential controller, technician, and systems specialist individual and team job performance measures. Such measures can be used to compare alternative systems designs to one another and the existing baseline. Similarly, the baseline and future KSA matrices can provide a basis for training requirements to support the transition to the modernized NAS.

17. Justification/History:

The requirement for a methodology to identify, describe, and analyze gaps between current and future workforce KSA and staffing profiles was identified in late 1997 by the Administrator's NAS Modernization Task Force ("#11: Develop an overall agency plan to resolve future workforce issues as the NAS modernizes: Retention, Training, Technical Competencies, Skills, Hiring, Outsourcing, Software Maintenance"). Further work by the NAS Sustainability Core Team in Q2 FY98 defined the basic approach and framework for gap analysis, and recommended integration of workforce analysis into the FAA AMS.

Moreover, P.L. 100-591 ("Air Traffic Controller Performance Research") called for FAA research on "(T)he attributes and aptitudes needed to function well in a highly automated air traffic control system, and development of appropriate testing methods for identifying individuals possessing those attributes and aptitudes." This represents an on-going research requirement as future operations concepts such as Free Flight and phased modernization emerge and evolve.

In the near-term, ATS must replace controllers, technicians, and systems specialists that attrite from the workforce through retirement, death, transfer, and promotion between FY 1999 and FY 2001. Therefore, ATS will require valid and legally defensible selection procedures to systematically assess applicants in order to select the few from among the many that possess the appropriate knowledge, skill, and ability (KSA) profiles to succeed in occupational training and/or on the job.

17. Justification/History (Continued):

Those selection tools must be reliable and valid by federal law, regulation, and agency policy. Fairness in selection is an issue under civil rights law (29 **CFR** 1607 and 42 **USC** 2000), departmental and agency performance goals, and for agency employee and external interest groups. This systematic, longitudinal research will evaluate the reliability, validity, fairness, and utility of ATS workforce selection procedures, and identify changes in KSA profiles associated with new NAS technologies so that ATS selection procedures continue to evolve in parallel with changing job requirements.

These requirements are summarized in the FY2000 ATS Human Factors Research Project Description which calls for the development and delivery of "Selection methodologies, guidelines, and criteria for NAS personnel."

18. Issues:

This research will require collection of controller and technician training and on-the-job performance data for research purposes only; therefore, formal coordination with employee bargaining agents will be required. The research will be conducted in accordance with the Department of Health and Human Services *Federal Policy for the Protection of Human Subjects* (45 **CFR** 46) and the American Psychological Association *Ethical Principles of Psychologists* and *Code of Conduct*. Research data collection protocols will be submitted to the FAA Institutional Review Board (IRB) for approval.

19. Transition Strategy:

Transition to implementation will be made directly through agency clients because prototypes in this technological area become the end product. Parallel forms of the AT-SAT will be directly delivered to the program office responsible for management, oversight, and execution of the controller selection process. The VIGOR technology was directly integrated into the AF/BEST software.

20. Impact of Funding Deferral:

Failure to validate and incrementally improve the predictive utility of the next generation of selection tests will result in continued avoidable costs through false positives (e.g., persons hired on the basis of testing who go on to fail or perform poorly). Failure to develop parallel forms will result in significant risk of test compromise and score inflation, resulting in poorer quality hires and their associated avoidable costs. Moreover, failure to validate and evaluate those selection tools exposes ATS to significant, and avoidable, legal risks. Finally, failure to evaluate the fairness of ATS workforce selection tests preclude an assessment of the degree to which selection contributes (or not) to the FAA goal of reducing minority and female under-representation as compared to previous Affirmative Employment Program results in safety-related occupations.

21. R&D Teaming Arrangements:

CAMI works closely with cognizant management teams throughout the agency, particularly the Air Traffic and Airway Facilities services. CAMI collaborates with international research laboratories and operating organizations (e.g., EuroControl, Netherlands, Sweden, Russia, Canada, Germany) to support common employee selection standards in an increasingly globalized aviation system. CAMI collaborates with other United States federal laboratories (e.g., USAF, USN) and centers of excellence when it appears that such collaboration will further mission objectives.

22. Special Facility Requirements:

CAMI facilities are sufficient.

23. Approvals (Signature Authority):		Performing Organization	
_____ John Staples, ARX-1 Date	Name Title	William E. Collins, Ph.D. Director, FAA Civil Aeromedical Institute, AAM-3	
_____ Jon L. Jordan, M.D., AAM-1 Date	Date		